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Environmental and Successional Relations of Aspen Communities in Central and Northern Utah

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ENVIRONMENTAL AND SUCCESSIONAL RELATIONS OF ASPEN COMMUNITIES IN CENTRAL AND NORTHERN UTAH

A Preliminary Analysis

Jan A. Henderson
1978

Aspen (Populus tremuloides) is a major forest cover type in central and northern Utah. It comprises about 35% of the forest dominated land in this area. It is mostly non-commercial timberland, but has moderately high values for watershed protection, range and wildlife values.

Aspen has the largest range of any tree species in North America. It also has a wide ecological amplitude, occurring from lower timberline in some areas to near upper timberline in others. In some areas it is found around bogs, lakes or streams and in others it occurs at the dry forest-sagebrush ecotone. The large amount of environmental variation that aspen can tolerate makes it difficult to understand the environmental factors which control its range.

At this point we know little more about aspen and its environmental relations than there is a lot of it scattered over a wide range of environmental conditions.

I have taken 1610 survey and reconnaissance plots (Henderson and West 1977) in central Utah (Wasatch Plateau) (Kerr and Henderson 1978, Henderson, Simon and Hartvigsen 1976) and northern Utah (Uinta Mountains and Northern Wasatch Mountains) (Henderson et al. 1976, 1977) for the purpose of defining and describing the forest habitat types in these areas. Of this number 845

(roughly half) had aspen as a component and 255 were aspen dominated without conifers.

The objective of this paper is to analyze these 1610 plots (especially the 845 with aspen): 1) to determine the relations between environmental features such as slope, aspect, elevation and the distribution of seral vs. climax aspen; 2) to estimate, if possible, through analysis of the age structure of these sampled stands, the rate of succession from aspen to conifer.

RESULTS

Objective 1

A summary of environmental relations by forest habitat type in central and northern Utah is presented in Table 1. It gives the average slope and elevation and the modal aspect for all habitat types encountered. It also separates plots in each habitat type with aspen occurring on them and gives the total number of plots in each type plus the number with aspen. Some types, e.g. Potr/Bromus and Potr/Elymus glaucus are exclusively aspen dominated while others have little or no aspen occurring on them.

Constancy is the percent of plots in a particular habitat type with aspen as a component. Average slope is calculated with a 95% confidence interval for the mean where the sample size is more than 4. The modal aspect was determined by graphing the aspects of each type on polar chart paper (Figure 1) and averaging the three most common aspects. Average elevation is the arithmetic average with 95% confidence limits. Blanks indicate areas where a habitat type was not encountered. NA indicates

situations where data are not available because aspen did not occur on a particular habitat type, such as on the Pien-Abla/Vame habitat type in Northwestern Utah. In some cases the modal aspect was not apparent such as the Abla/Rimo h.t. in the Huntington canyon area where plots were scattered over the entire northern hemisphere.

The geographical areas listed under each habitat type refer to: 1) the Northern Wasatch mountains, and other areas of the Wasatch, Caribou, Sawtooth National Forests in northern Utah and southern Idaho ("NW Utah"); 2) the Wasatch and Ashley National Forest areas in the Uinta Mountains ("Uintas"); 3) the Huntington Canyon area of the Manti-Lasal National Forest ("Huntington"); 4) the Price District of the Manti-Lasal National Forest which includes the Huntington Canyon area but does not include the plots taken separately and listed under "Huntington" ("Price").

The aspen habitat types with a large enough sample to determine a meaningful mean slope and elevation and modal aspect are clusterd on the southern quadrant of the compass (Fig. 1) for central Utah. Seral and climax aspen occur in all quadrants (Fig. 2) however climax aspen is nearly restricted to southerly aspects and seral aspen is nearly restricted to northerly aspects. The probability of an aspen dominated community being seral or climax relative to aspect on the Price District of the Manti-Lasal National Forest is given in Table 2. These figures give results which are not interpreted at all. For example most, if not all, of the

Table 1. Relationships between environmental features and forest habitat types in central and northeastern Utah

(See Appendix for more detailed data)

Habitat type	No. stands	No. w/aspen	Constancy	All Plots Ave. slope (%)	All Plots Modal aspect	All Plots Ave. elev.	Aspen Only Ave. slope (%)	Aspen Only Modal aspect	Aspen Only Ave. elev.
Brome									
NW Utah	3	3	100	27	75°	8050			
Uintas									
Huntington	42	42	100	39±5	218°	9310±98			
Price	88	88	100	40±3	184°	9133±85			
Potr/Syor-Bere									
NW Utah	26	26	100	27±5	138°	7213±226			
Uintas									
Huntington	3	3	100	52	209°	9127			
Price	32	32	100	50±7	145°	8994±183			
Potr/Elgl									
NW Utah	8	8	100	18±12	80°	7873±487			
Uintas									
Huntington	6	6	100	46±18	142°	9120±113			
Price	25	25	100	40±7	130°	9022±217			
Abla-Potr/Rimo									
NW Utah									
Uintas									
Huntington									
Price	2	2	100	23	196°	9700			
Potr-Quga/Syor-Bere									
NW Utah									
Uintas									
Huntington									
Price	2	2	100	63	124°	8700			
Abla-Potr/Brome									
NW Utah									
Uintas									
Huntington	1	1							
Price			100	35	315°	900			
Potr/Cage									
NW Utah									
Uintas	9	9	100	8±5	75°	8561±374			
Huntington									
Price									
Potr/Junco									
NW Utah									
Uintas	11	11	100	19±8		8633±216			
Huntington									
Price									
Abla/Rimo									
NW Utah	56	6	11	28±5	337°	8521±159	27±20	330°(100%)	8083±535
Uintas	37	8	21.6	20±6	335°	10,175±179	25±12	160°	9785±385
Huntington	67	45	67.2	32±3	358°	9417±68	32±4	E,W,N	9406±77
Price	33	29	87.9	34±7	322°	9347±188	33±7		9412±130
Abla/Bere (including Pien-Abla/Bere)									
NW Utah	102	48	47.1	34±3	326°	7696±114	30±4	324°(70%plots)	7518±157
Uintas	38	26	68.4	29±7	40°	8992±211	27±9	42°	8753±198
Huntington	9	9	100	43	247°	9048	43	247°	9048
Price	111	89	80.2	45	357°	8947	43	357°	8911
Pien-Abla/Vame (including Abla/Vame)									
NW Utah	23	0	0	37±7	8°	8086		NA	
Uintas	1	1	100	15	55°	8320	15	55	8320
Huntington	2	0	0	50	356°	9275		NA	
Price	4	2	50	52	333°	9350	44	301°	9250
Pien-Abla/Vaca (including Abla/Vaca)									
NW Utah									
Uintas	4	0	0	25		9223		NA	
Huntington	13	10	76.9	48±11	12°	8932±209	43±10	17°	8868±242
Price	6	2	33.4	54±8	7°	9125±476	52	31°	9325

Habitat type	All Plots					Aspen Only			
	No. stands	No. w/aspen	Constancy	Ave. slope (%)	Modal aspect	Ave. elev.	Ave. slope (%)	Modal Aspect	Ave. elev.
Pien-Abla/Rimo									
NW Utah									
Uintas									
Huntington	44	33	75	40±5	0°	9285±110	38±6	(NW,W,SW,NE, E,SE)	9232±129
Price	50	18	36	40±5	4°	9596±152	34±10	39°	9286±260
Pien-Abla/Osch									
NW Utah									
Uintas									
Huntington	6	6	100	34±12	340	9000±521	34±12		9000±521
Price									
Pien-Abla/Arco									
NW Utah									
Uintas									
Huntington									
Price	8	2	25	41±15	0°N	9369±323	26		9375
Abla/Arco									
NW Utah	5	5	100	20±17					
Uintas	3	3	100	13					
Huntington									
Price	1	1	100	45	318				
Abla/Osch									
NW Utah	35	21	60	29±6	0°	7656±215	28±6	6°	7754±266
Uintas	2	1	50	15		8940	25	322	8720
Huntington									
Price	9	9	100	32±15		9339±381	32±15		9339±381
Abla/Acgl									
NW Utah	10	2	20	39±12	17°	6795±296	23	N,SW	6400
Uintas	2	2	100	40					
Huntington									
Price	3	3	100	34					
Abla-Psme/Phma									
NW Utah									
Uintas									
Huntington									
Price	13	13	100	56±10	31°	8669±301	56±10	31°	8669±301
Psme/Phma									
NW Utah	42	6	14.3	67±5	8°	6106±167	60±16	30°	6327±634
Uintas									
Huntington									
Price	2	1	50	70		8275	65	314	8550
Psme/Bere									
NW Utah	40	5	12.5	51±6	329°	6786±269	42±28	309°	6370±551
Uintas	25	12	48	37±7	33°	8356±319	29±6	191°	8327±574
Huntington									
Price	25	14	56	50±9	45°	8998±224	46±13	174°	9050±399
Psme/Acgl									
NW Utah	15	5	33.3	58±13	30°	6455±303	43±26	31°+S	6650±781
Uintas	1	0	0	65	20°	7860		NA	
Huntington									
Price	3	2	66.7	62		8400	56		8600
Psme/Cele									
NW Utah	10	0	0	37±12	337°	7302±433		NA	
Uintas									
Huntington									
Price	15	5	33.3	69±8	197°	8523±363	63±20	180°	8970±283
Abco/Phma									
NW Utah	8	2	25	61±17	27°	6281±762	58	SE,N	7175
Uintas									
Huntington									
Price	1	1	100	47	73°	8450	47	73°	8450

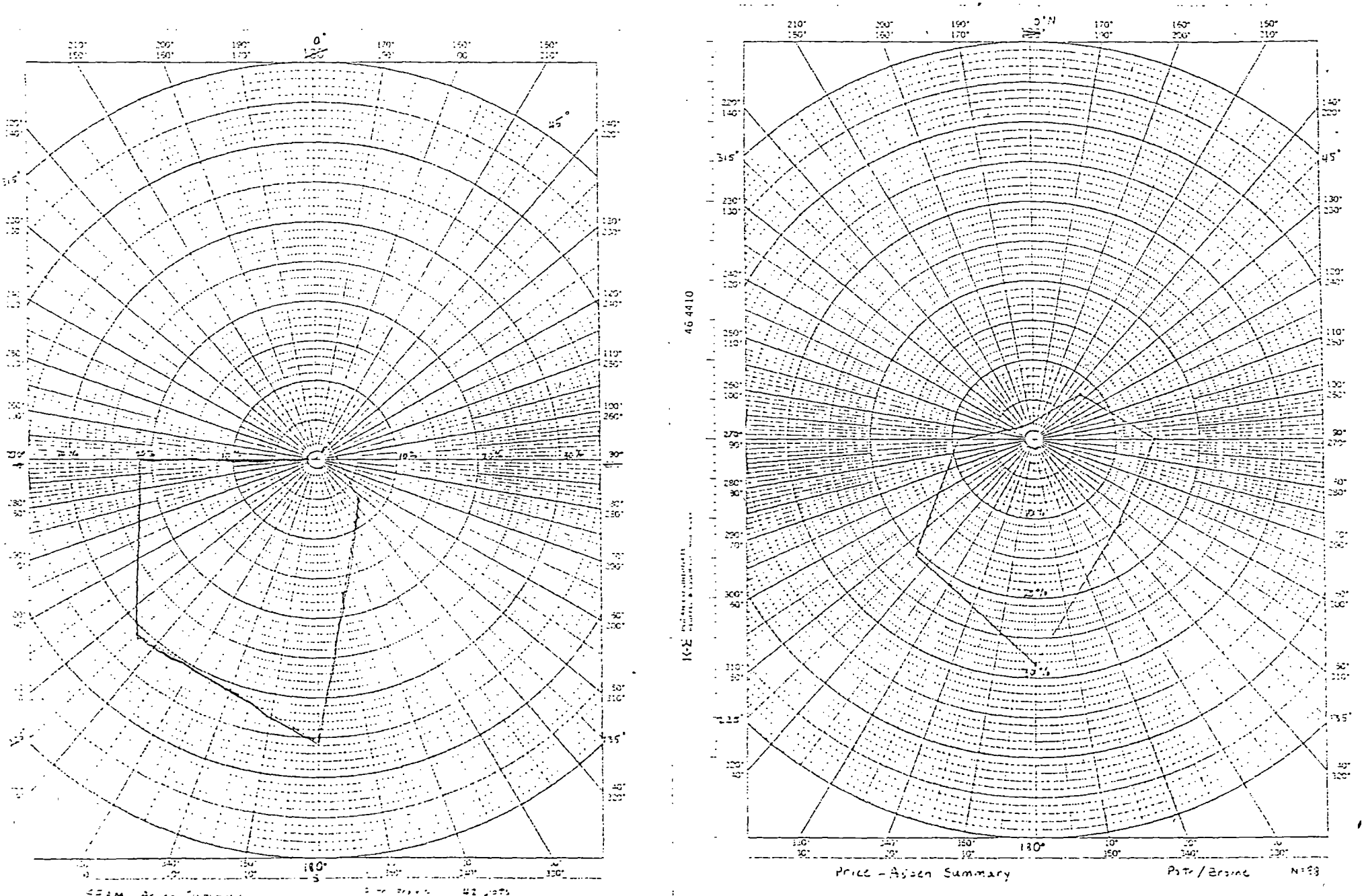

Figure 1A. Distribution of aspects of selected habitat types in the Price District, Manti-Lasal National Forest. Length of line along coordinates represents percent of plots on that aspect. Left figure represents Potr/Brome h.t. in the Huntington Canyon area n = 42. Right figure represents the same h.t. throughout the Price District n = 88.

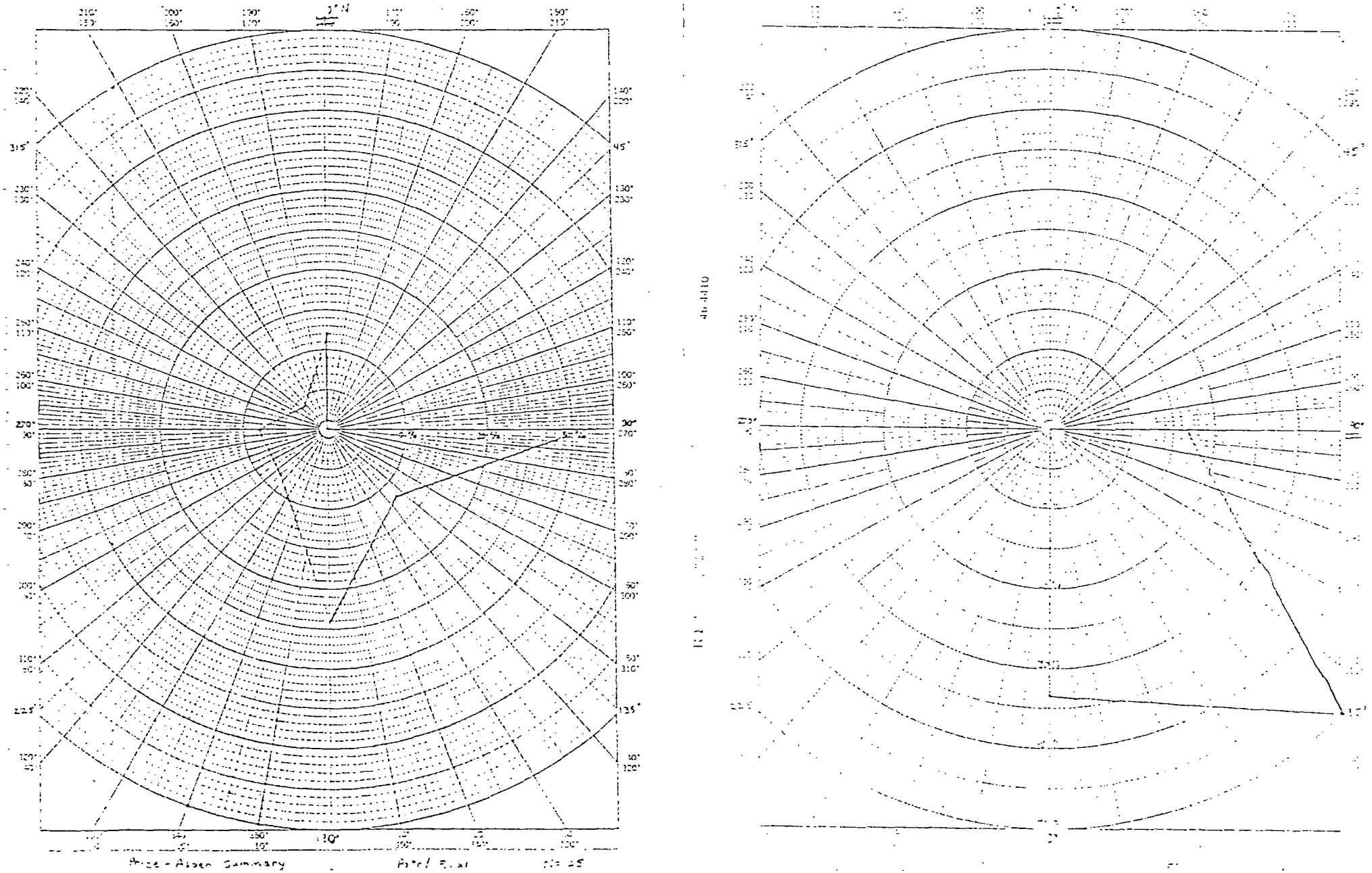

Figure 1B. Distribution of aspects for Potr/Elgl h.t. on left for Price District n = 25. Same habitat on right for the Huntington Canyon area n = 6.

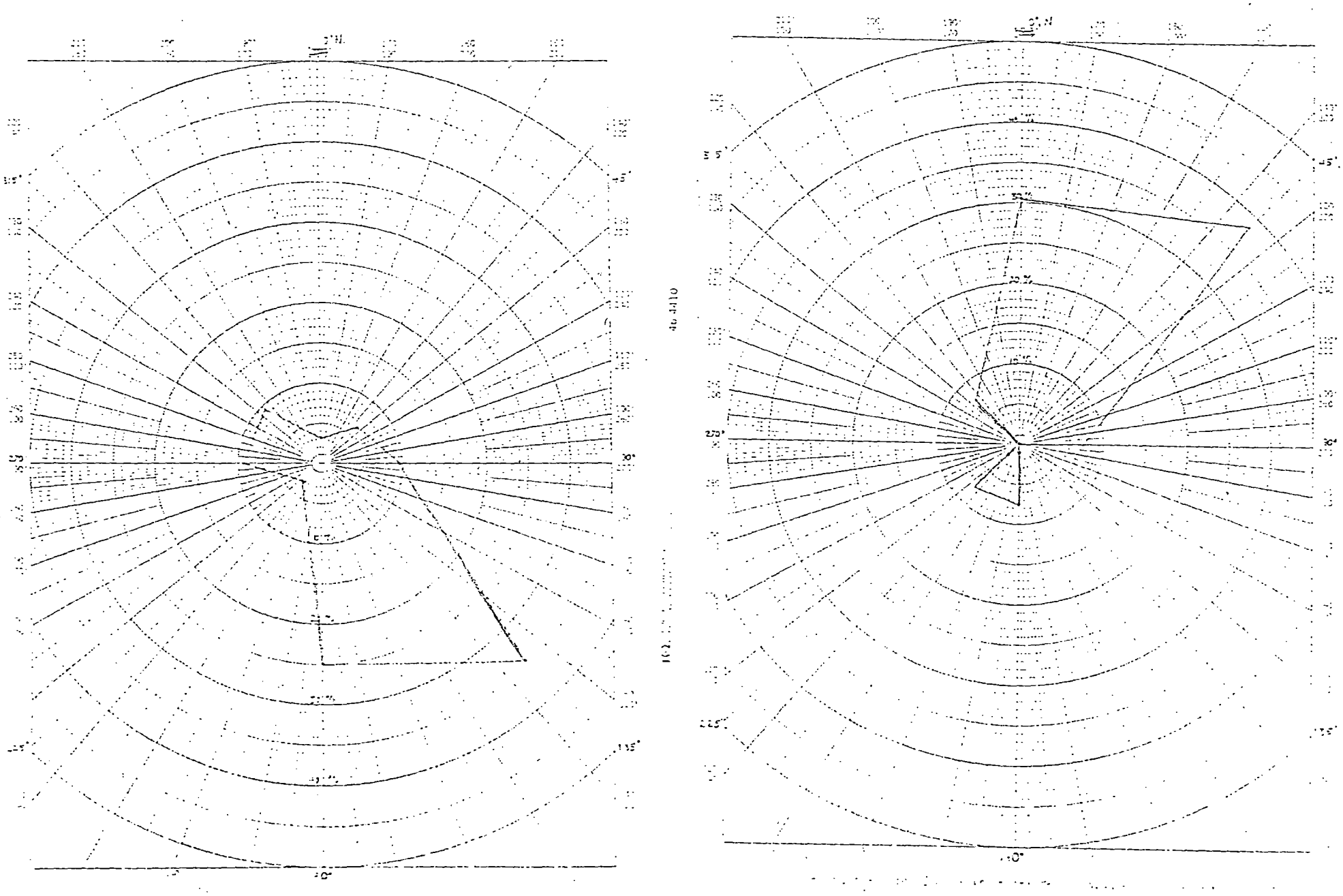

Figure 1C. Distribution of aspects for Potr/Syor-Bere h.t. on left for Price District n = 32. Figure on right represents the Abla-Psme/Phma h.t. on the Price District n = 13.

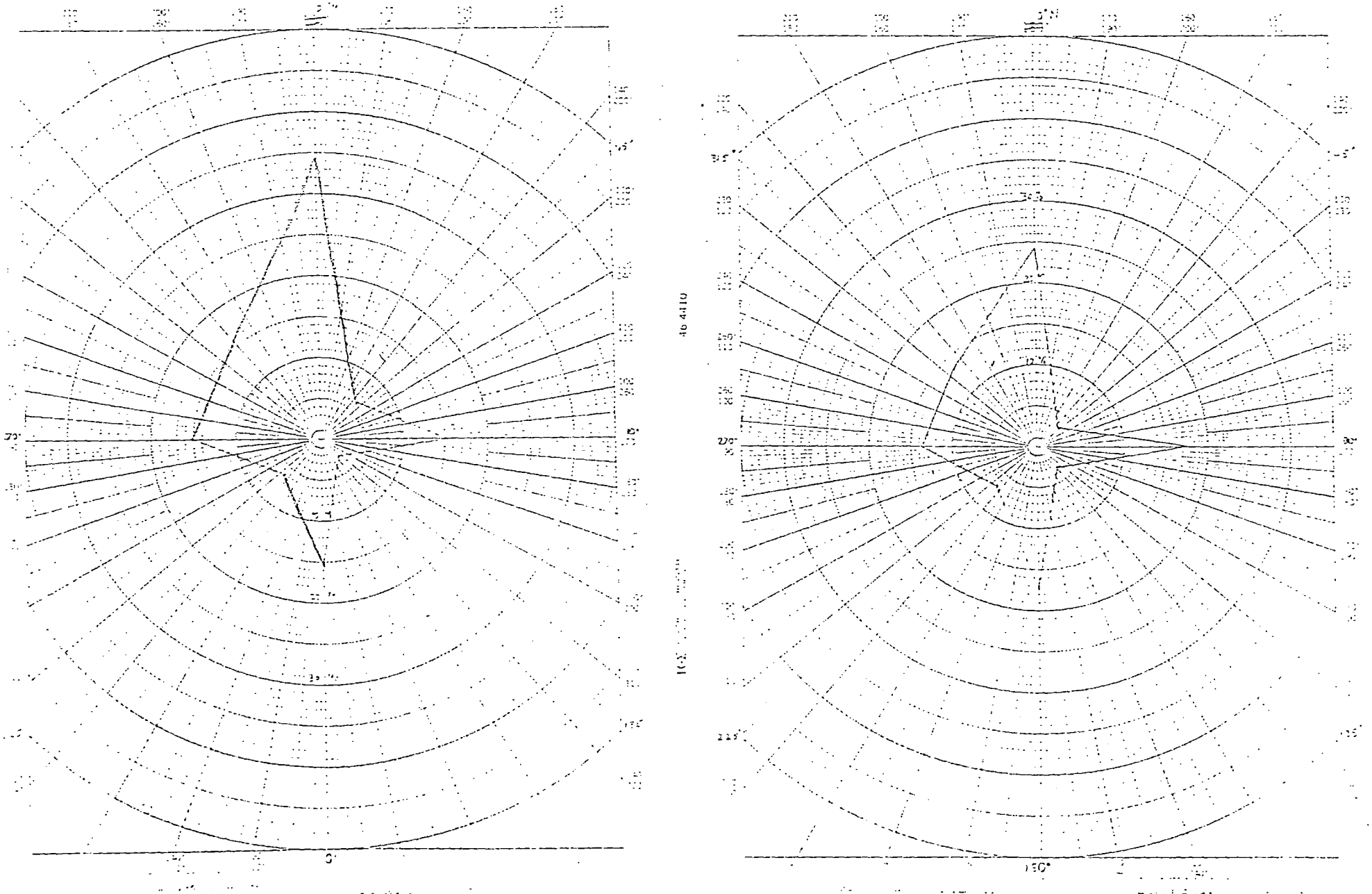

Figure 10. Distribution of aspects for Abla/Rimo h.t. throughout the Price District, Manti-Lasal National Forest. Left figure represents all plots in this h.t. (n = 33). The right figure represents those plots on this h.t. with aspen as a component (n = 29).

Table 2. Percentage of seral vs. climax aspen by quadrants of the compass. (On Price District)

	Quadrant			
	North (315°-45°)	East (45°-135°)	South (135°-225°)	West (225°-315°)
Percent seral	89%	56%	29%	59%
Percent climax	11%	44%	71%	41%
Percent of stands represented	25%	25%	24%	25%

aspen stands in the north Quadrant are believed to be seral even though there were no direct indications (e.g., Abla reproduction) to believe otherwise. These stands thus key to Potr series; however it is likely that they represent Abla h.t.s. Aspen stands which are seral on conifer habitat types may be temporarily without conifers in them for various reasons, including disturbance (cattle or sheep grazing), herbivory (snowshoe hare or other herbivores may decimate any reproduction of subalpine fir), competition from understory vegetation, lack of seed source or chance.

An interesting comparison can be made between the mean and modal values for each of the common habitat types in central Utah (Fig. 1) and the distribution of plots within each type (Fig. 2a, 2b). The distribution of plots falls evenly over all quadrants of the compass (Table 2) and in this area mostly between 8-10,000 feet elevation. However, the mean values for slope and elevation show that there is little difference between many types. Moreover, the aspen dominated habitat types are clearly clustered in the southern quadrant and the Abies dominated habitat types are clearly clustered in the northern quadrants. Although there is a good representation of plots in the western and eastern quadrants no major type had its modal aspect there. The conclusion to be drawn from this observation is that the difference between facing north vs. facing south is much more significant to the development of the communities than the difference between facing east or west.

Figures 2a and 2b also indicate that slope and aspect by themselves are not good predictors or "explainers" of the distribution of climax communities since some conifer dominated types occur interspersed with aspen types as shown on the polar charts used in Figures 2a and 2b. Part

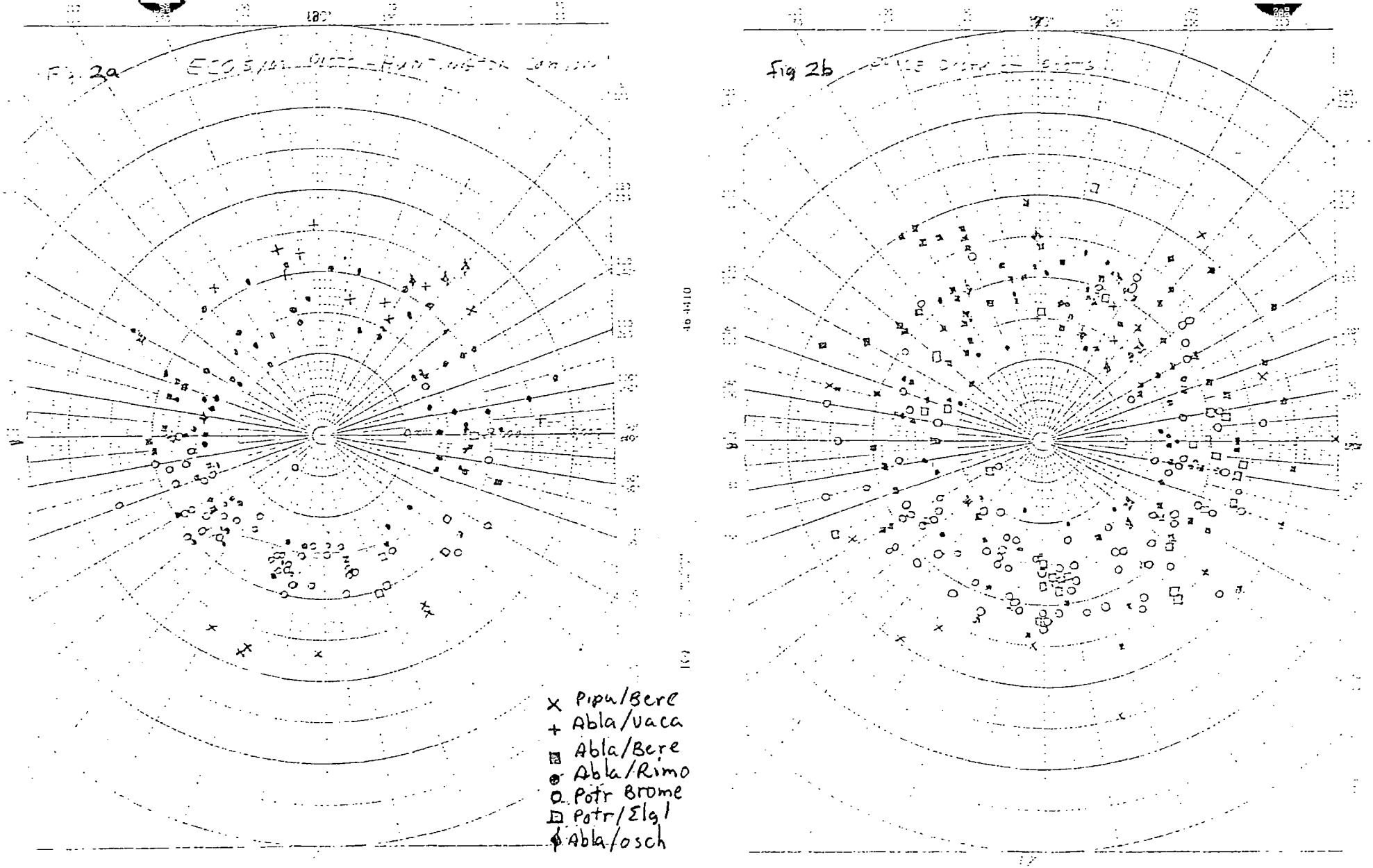

Figure 2. Distribution of plots as keyed by habitat type with aspen as a component. Left figure represents the Huntington Canyon area. Right figure represents the Price District. Open symbols are used for aspen series habitat types. Other symbols are for conifer dominated h.t.s.
x - Pipu/Bere; + - Abla/Vaca; ▣ - Abla/Bere; ⊙ - Abla/Rimo; ⊕ - Abla/Osch; o - Potr/Bromus; □ - Potr/Elgl.

of the explanation of this is that those Abies plots which occur on southerly aspects between 8500 and 9500 feet usually occur on gentle slopes (<10%) or on moist microsites such as adjacent to a spring or on a concave slope.

Figure 2 presents the aspects of plots in major habitat types both with and without aspen. These represent the trends in aspect which are represented as the modal aspect in Table 1.

Table 2 gives the distribution and frequency of plots with aspen and without on various habitat types in the study area. Some information is available on some studies, e.g. Uintas, and is not available on others, e.g. Price District. This explains the "not collected" category or blanks in the table.

DISCUSSION AND CONCLUSIONS

This analysis has concentrated on data from the Huntington Canyon area and the Price District of the Manti-Lasal National Forest in central Utah. It has shown that there is a strong tendency for climax aspen to dominate the southerly aspects and for subalpine fir to dominate the northerly aspects. Although expected to be more significant in controlling the distribution of communities in this area, bedrock and soil features were not readily correlated to habitat type or series. The bedrock in the area is predominantly sandstone and shale and the soil is usually sandy loam in texture, although varying in depth.

That aspen occurs on all aspects and topographic conditions is readily seen in the attached figures and tables. The distribution of

subalpine fir on different slopes and aspects is more restricted, occurring mostly on northerly aspects. When on southerly aspects it occurs often on micro-sites somewhat moister than normal for that aspect.

It would seem that there is a subtle balance between fir with aspen and aspen by itself. The controlling factor here I believe to be available moisture (ultimately plant moisture stress). Subalpine fir is absent or "accidental" on the warmer slopes, aspects and topographic positions which creates greater moisture stress and less available water there.

I believe that the moisture stress in these situations is so close to being suitable to subalpine fir (in which case aspen then becomes seral) that the individuals and clumps of fir which occur sporadically on southerly aspects probably date back to a cooler and moister period (such as the little ice age ca 1645-1715) and that given a cooling trend these lands may once again support subalpine fir.

The effect that domestic livestock have had on these ecosystems is mostly speculation. However, some soil loss due to reduction in plant cover or litter may be effective in the persistence of otherwise seral aspen on marginal sites.

Aspen dominated stands in northern Utah were not as well sampled. In this area aspen tends to enjoy climax status only in more specialized habitats (Fig. 3,4). In this case too, climax aspen occurs on warmer and drier slopes and aspects along the environmental gradients. In the Uinta Mountains, climax aspen stands tended to occur more on easterly aspects. There were many unsampled climax aspen stands which occur on private land in the Uintas and usually occur near lower timberline.

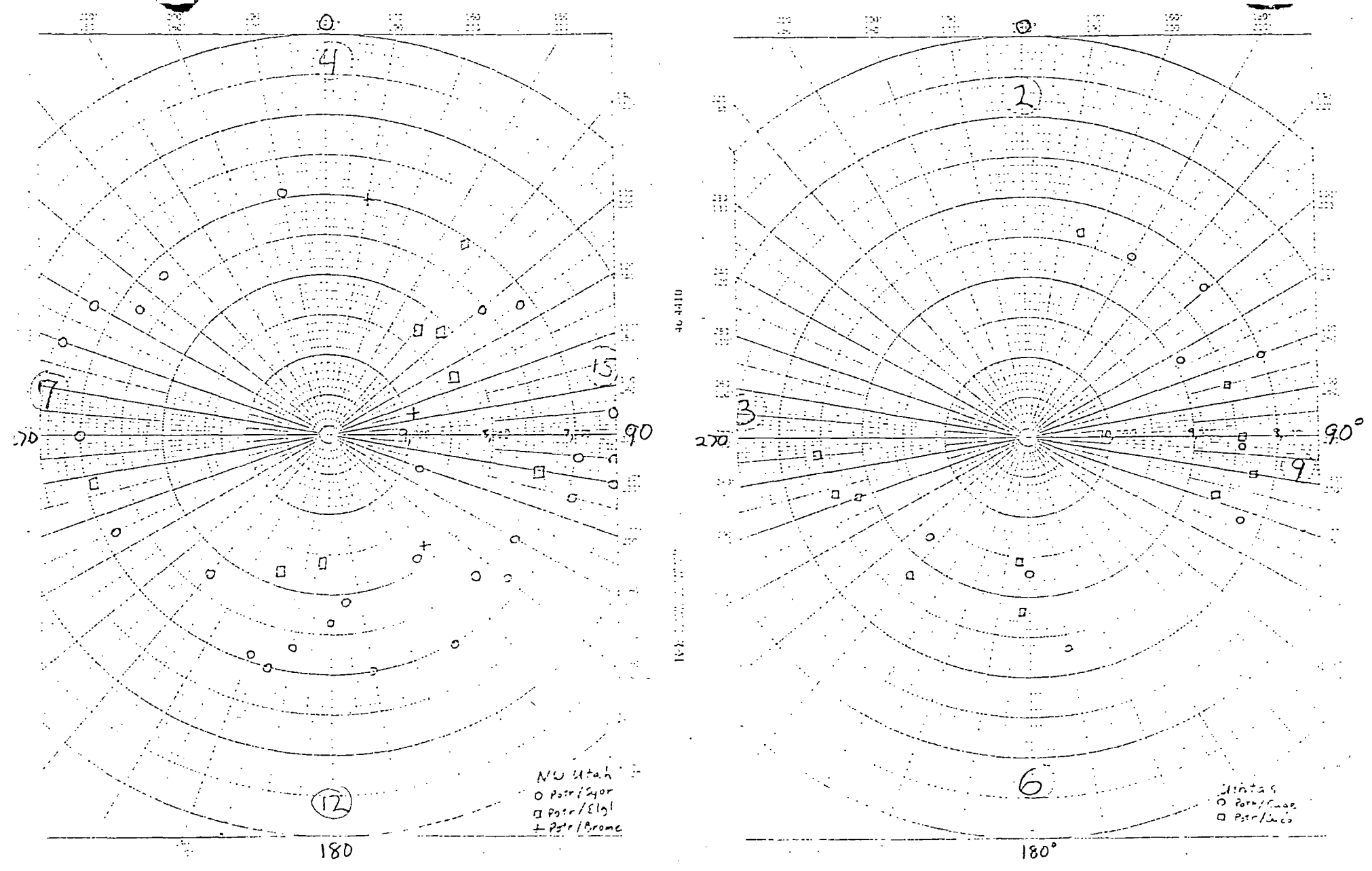

Figure 3. Distribution of plots in aspen h.t.s. in northwestern Utah (Left figure) and Uinta Mountains (Right figure). Numbers in large circles are the number of plots in each quadrant of the compass.

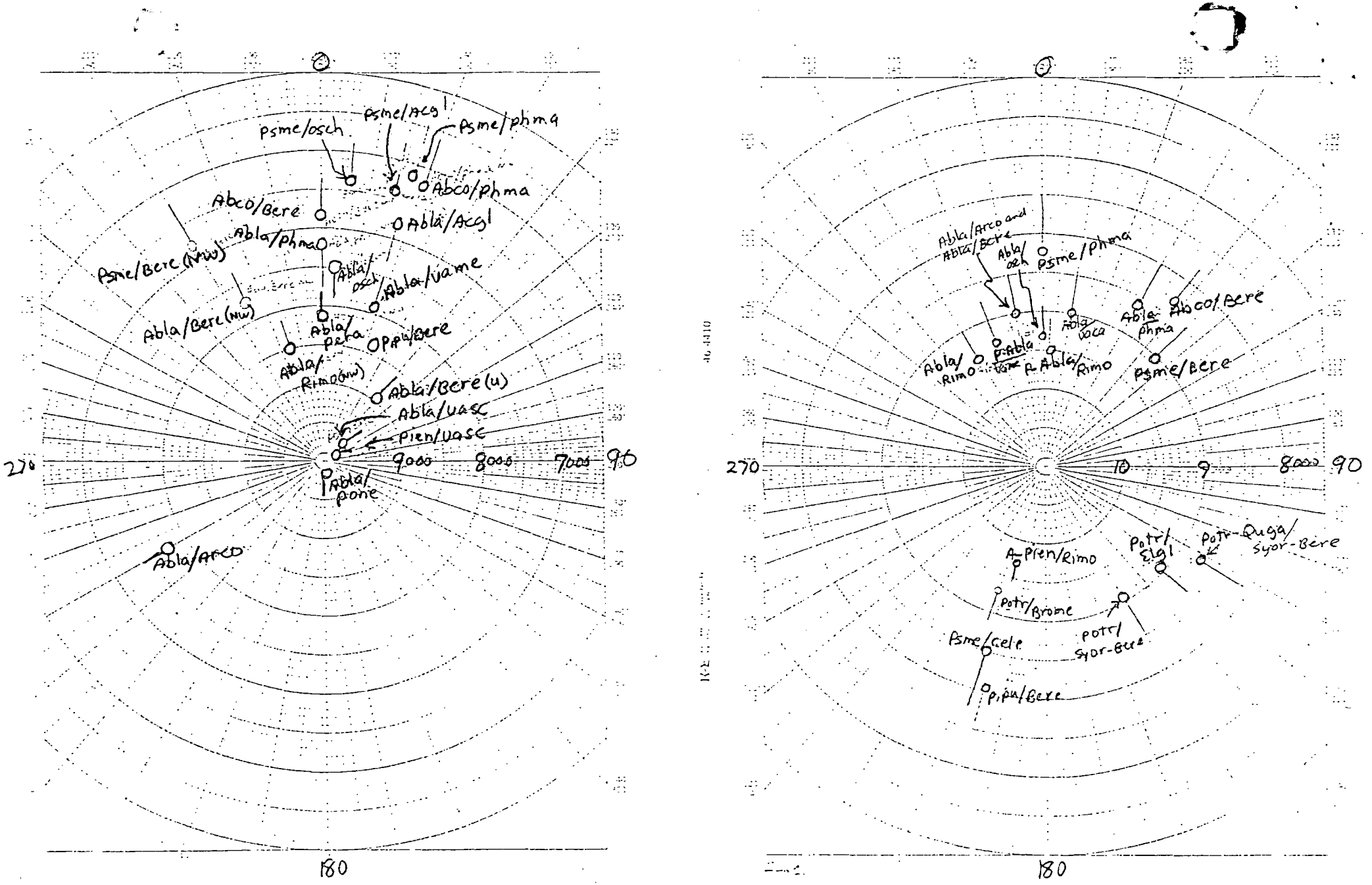

Figure 4. Modal aspect and average slope and elevation of common habitat types in northern Utah (Left figure) and Price District, Manti-Lasal National Forest (Right figure). Elevations in feet, aspect in degrees, slope represented by the length of the bar where each unit of length represents 10% slope. A bar 5 units long indicates an average slope of 50%.

These too are believed to occupy warmer and drier habitats. Climax aspen stands in northern Utah tend to occur on more southerly aspects. Since many of these aspen stands were believed to be seral at the beginning of the sampling period and only mature or climax stands were included in the sampling, climax aspen communities were undersampled in northern Utah. The lack of plots in this type does not allow us to do a very detailed analysis of aspen in this area.

Objective 2

I tried, through an analysis of stand ages and percent cover of aspen to predict the rates of conversion from seral aspen to climax conifer. In Fig. 5A, I plotted the ages and coverages for aspen for all plots in central Utah on the Abies lasiocarpa/Ribes montigenum and the Abla-Pien/Rimo habitat types. Although there is a weak tendency for the cover of aspen to decline with time, there is certainly no evidence to suggest that the process is predictable and that a seral aspen stand on this h.t. will succeed to the climax composition in a certain period of time. However, by 150 years it would appear, most stands are no longer aspen dominated.

In Fig. 5B the cover of aspen is compared to age of the stand for the Abies lasiocarpa/Berberis repens h.t. found in the Price District area. The same weak relationship appears as was shown on the Abla/Rimo h.t. for the same area. By 150 years most aspen has fallen from the stands and by 200 years the cover has dropped to near zero. It is interesting to note that for both habitat types few stands occur which are older than 200 years with the maximum age of about 290 years. The lack of stands older than 263 years (dated from the end of the little ice age ca 1715) appears in

other areas of Utah also.

The problems here in predicting the rate of aspen conversion to conifer are several. Aspen probably doesn't live much beyond 150 years in this area with or without conifer competition. Aspen stands without conifer reproduction but on conifer habitat types would begin breaking up about 150 years and probably be replaced by another stand of aspen.

Another problem deals with stand history too. But in this case if conifer invasion was earlier or more rapid the succession would be more rapid. In such cases aspen might not be present in the stand in sufficient quantity to sucker and assume dominance before the fir reproduces by seed.

An analysis of the rate of succession from aspen to conifer is probably still possible for this area. Before this is possible, I believe that the habitat types (and phases) need to be fully worked out and that the possible successional pathways for the types needs to be determined. For example, for the Abla/Pera h.t. in northern Utah we believe that there are four major successional pathways to a mature Abla-Pien/Pera climax c.t. (Fig. 16). The rate of "conversion" from aspen to conifer is quite different in each case. A good model for succession in each case would facilitate this prediction.

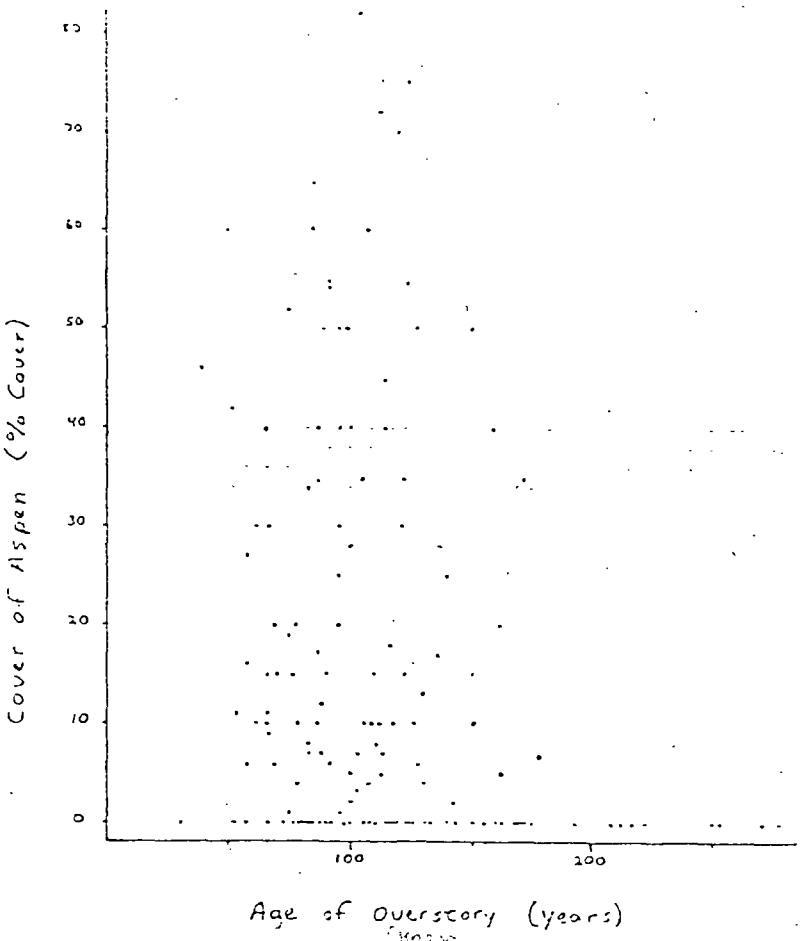

Figure 5A. Cover of aspen vs age of overstory for Abla/Rimo and Pien-Abla/Rimo h.t.s. on the Price District, Manti-Lasal National Forest.

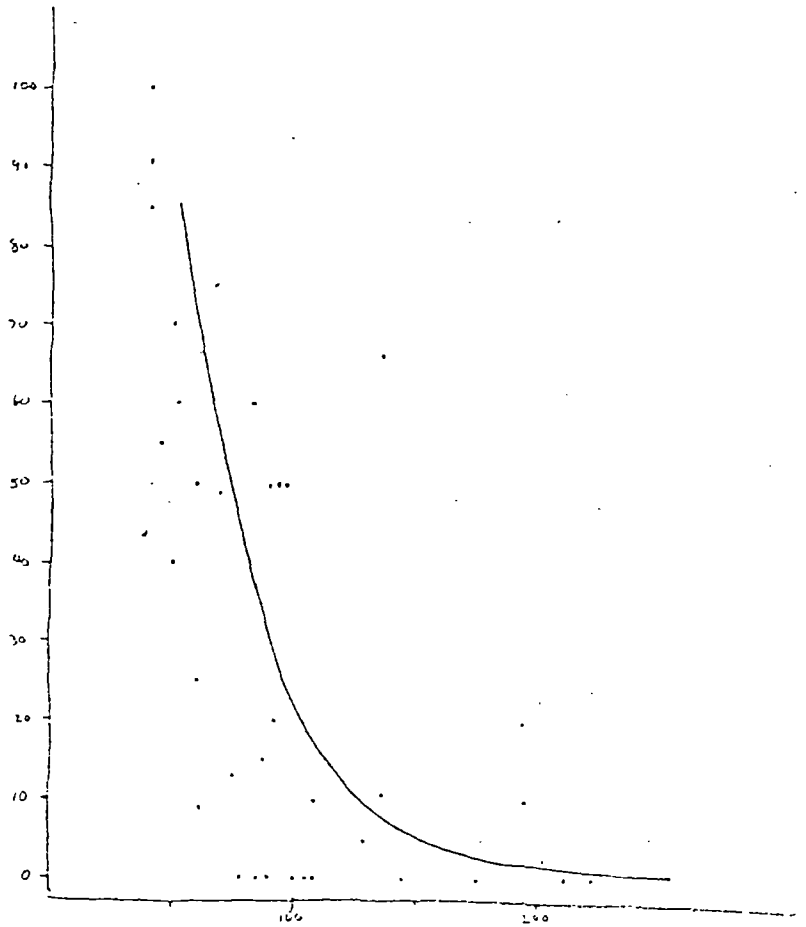

Figure 5B. Proportion (relative cover) of aspen vs age of overstory for the Abla/Bere h.t. on the Price District, Manti-Lasal National Forest.

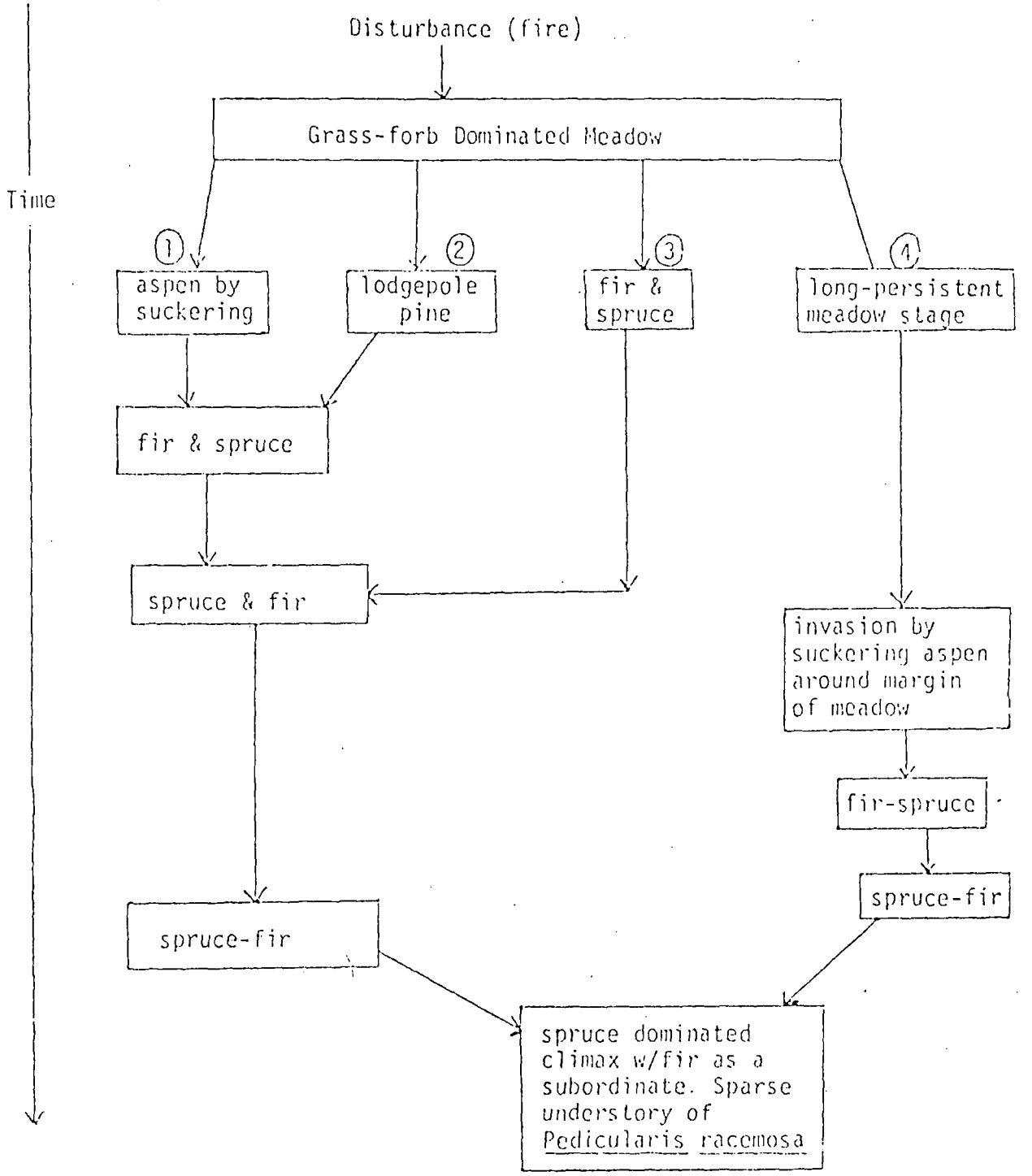

Fig. 35. Four basic successional pathways which can lead to the zonal Abies lasiocarpa/Pedicularis racemosa climax.

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